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(22)Date of filing : **20.06.1995**

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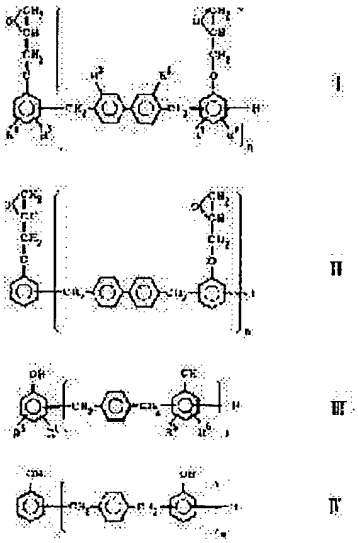
(72)Inventor : **IBUKI KOICHI**

(54) EPOXY RESIN COMPOSITION AND SEMICONDUCTOR SEALED DEVICE

(57)Abstract:
PURPOSE: To obtain an epoxy resin composition that can give a semiconductor sealed device excellent, for example, in humidity resistance and soldering heat resistance by adding a specified epoxy resin, a phenolic resin, an inorganic filler, and a hardening accelerator in a prescribed weight ratio.
CONSTITUTION: (A) An epoxy resin represented by formula I (wherein R1, R2, R3 and R4 represent each H or an alkyl), for example, an epoxy resin represented by formula II ((n) is an integer of 0 or above), (B) a phenolic resin represented by formula III (wherein R5 and R6 each represents H or an alkyl), for example, a phenolic resin represented by formula IV, (C) an inorganic filler, for example, silica powder, and (D) a hardening accelerator, for example, an imidazole hardening accelerator are prepared. These components excluding the (C) component are mixed with the component (C) in an amount of 50 to 95wt.% based on the resin composition to obtain an epoxy resin composition. A semiconductor chip, such as an integrated circuit and a transistor, is sealed with a hardened product of this epoxy resin composition to produce a semiconductor sealed device. In the resultant semiconductor sealed device, disconnection due to corrosion of the electrodes and a leakage current due to moisture occur remarkably less.



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DN 126:186898
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TI Moisture- and solder heat-resistant epoxy resin compositions and semiconductor devices sealed with them
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PA Toshiba Chem Prod, Japan
SO Jpn. Kokai Tokkyo Koho, 5 pp.
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LA Japanese
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Section cross-reference(s): 76

FAN.CNT 1

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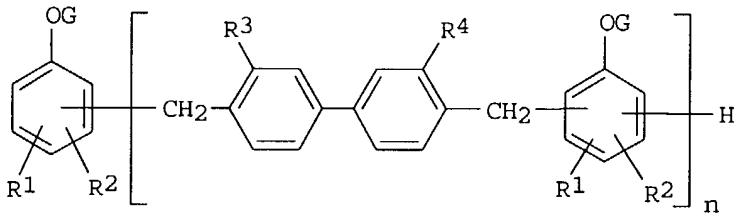
PI	JP 09003161	A2	19970107	JP 1995-176718	19950620
PRAI	JP 1995-176718		19950620		

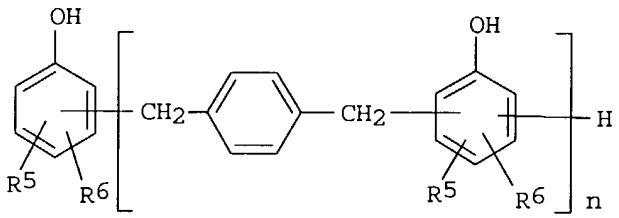
CLASS

PATENT NO.	CLASS	PATENT FAMILY CLASSIFICATION CODES
JP 09003161	ICM	C08G059-32
	ICS	C08G059-62; C08L063-00; H01L023-29; H01L023-31

GI



I



II

AB Title compns. comprise (A) epoxy resins I (R1-4 = CnH2m+1; G = glycidyl; m, n .gtoreq.0), (B) phenolic resins II (R5, R6 = CmH2m+1; m, n .gtoreq.0), and (C) 50-95% (vs. resins) inorg. fillers, and (D) curing accelerators. Thus, a compn. comprising I (R1-4 = H; n .gtoreq.0) 8.9, II (R5, R6 = H; n .gtoreq.0) 6.1, powd. SiO2 84, a curing accelerator 0.3, an ester wax 0.3, and silane coupler 0.4%, kneaded, crushed, and transfer-molded with semiconductor chips to give semiconductor devices showing H2O absorption 0.39% at 127.degree. for 24 h under unsatd. vapor pressure 2.5 atm, glass temp. 125.degree., bending strength 18.0 kg/mm2 at

room temp. and 2.7 kg/mm2 at 220.degree., and good resistance against solder heat (250.degree., 10 s) and moisture (85.degree., 96 h, relative humidity 85%).

ST solder heat resistance epoxy resin sealant; moisture resistance epoxy resin sealant; semiconductor device epoxy resin sealant; phenolic resin crosslinking agent epoxy resin

IT Phenolic resins, uses
RL: DEV (Device component use); MOA (Modifier or additive use); TEM (Technical or engineered material use); USES (Uses)
(crosslinking agents, for epoxy resins; moisture- and solder heat-resistant epoxy resin compns. contg. phenolic resin crosslinkers for sealing semiconductor devices)

IT Water-resistant materials
Water-resistant materials
(heat-resistant; moisture- and solder heat-resistant epoxy resin compns. contg. phenolic resin crosslinkers for sealing semiconductor devices)

IT Crosslinking agents
Sealing compositions
Semiconductor devices
(moisture- and solder heat-resistant epoxy resin compns. contg. phenolic resin crosslinkers for sealing semiconductor devices)

IT Epoxy resins, uses
RL: DEV (Device component use); POF (Polymer in formulation); TEM (Technical or engineered material use); USES (Uses)
(phenolic resin-crosslinked; moisture- and solder heat-resistant epoxy resin compns. contg. phenolic resin crosslinkers for sealing semiconductor devices)

IT Heat-resistant materials
Heat-resistant materials
(water-resistant; moisture- and solder heat-resistant epoxy resin compns. contg. phenolic resin crosslinkers for sealing semiconductor devices)

IT 7631-86-9, Silica, uses
RL: DEV (Device component use); MOA (Modifier or additive use); TEM (Technical or engineered material use); USES (Uses)
(fillers; moisture- and solder heat-resistant epoxy resin compns. contg. phenolic resin crosslinkers for sealing semiconductor devices)

IT 130401-11-5DP, polymers with phenolic resin glycidyl ethers
187344-76-9DP, glycidyl ethers, polymers with phenolic resins
RL: DEV (Device component use); IMF (Industrial manufacture); PRP (Properties); TEM (Technical or engineered material use); PREP (Preparation); USES (Uses)
(moisture- and solder heat-resistant epoxy resin compns. contg. phenolic resin crosslinkers for sealing semiconductor devices)

DERWENT-ACC-NO: 1997-115328

DERWENT-WEEK: 199711

TITLE: Epoxy! resin compsns. used for sealing semiconductor devices - contg. epoxy! resins, phenol resins, inorganic fillers, and curing accelerators

PATENT-ASSIGNEE: TOSHIBA CHEM CORP[TOSM]

PRIORITY-DATA: 1995JP-0176718 (June 20, 1995)

PATENT-FAMILY:

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APPLICATION-DATA:

PUB-NO	APPL-DESCRIPTOR	APPL-NO	APPL-DATE
JP 09003161A	N/A	1995JP-0176718	June 20, 1995

INT-CL (IPC): C08G059/32, C08G059/62 , C08L063/00 , H01L023/29 , H01L023/31

ABSTRACTED-PUB-NO: JP 09003161A

BASIC-ABSTRACT:

Epoxy resin compsns. contain essentially:

(A) epoxy resins of formula (1);

(B) phenol resins of formula (2);

(C) inorganic fillers in amts. of 50 - 95 wt. % of the resin compsn.; and

(D) curing accelerators.

R1, R5 = CjH2j+1;

R2, R6 = CkH2k+1;

R3 = ClH2l+1;

R4 = CmH2m+1; and

j, k, l, m, n = 0 or integer of at least 1.

USE - The resin compsns. are used for sealing, coating and insulating
electronic parts.

ADVANTAGE - The resin compsns. have high glass transition temp., improved heat
mechanical properties and low stress and no crack when soaked in a soldering
bath. The resin compsns. and semiconductor devices obtd. by sealing
semiconductor chips with their cured prods. have good moisture resistance and
soldering heat resistance and are not influenced by moisture (reduction of
breakage of wires caused by corrosion of electrodes and leakage of electric
current).

CHOSEN-DRAWING: Dwg.0/0

TITLE-TERMS: POLYEPOXIDE RESIN COMPOSITION SEAL SEMICONDUCTOR DEVICE CONTAIN
POLYEPOXIDE RESIN PHENOL RESIN INORGANIC FILL CURE ACCELERATE

DERWENT-CLASS: A21 A85 L03 U11

CPI-CODES: A05-C; A08-D01; A08-R01; A10-E08C; A12-E04; A12-E07C; L04-C20A;

EPI-CODES: U11-A07;

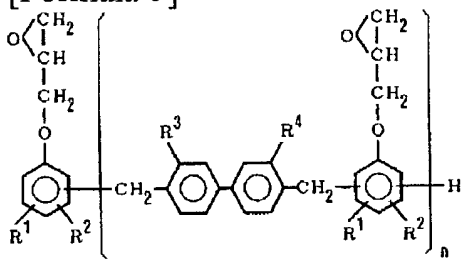
ENHANCED-POLYMER-INDEXING:
Polymer Index [1.1]
018 ; D01 D11 D10 D19 D18 D23 D22 D34 D73 D76 D42 D50 D94 D95 F34

* NOTICES *

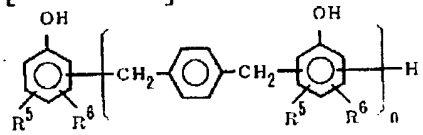
DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the semi-conductor sealing arrangement which closed the semiconductor chip with the epoxy resin constituent excellent in moisture resistance and solder thermal resistance, and its constituent.
[0002]
[Description of the Prior Art] In recent years, automation of the mounting process of a semiconductor device is promoted by the ED and coincidence of high integration and high-reliability-izing in the field of a semiconductor integrated circuit. For example, although it was soldering for every lead pin conventionally when the semiconductor device of a flat package mold was attached in the circuit board, recently, the solder immersion method and the solder reflow method are adopted.
[0003] The semiconductor device closed with the resin constituent which consists of an epoxy resin, conventional novolak mold phenol resin, and conventional silica powder, such as a novolak mold epoxy resin, had the fault that moisture resistance fell, when solder bath immersion of the whole equipment was performed. When the semiconductor device which absorbed moisture especially was immersed, peeling between closure resin, a semiconductor chip or closure resin, and a leadframe and an internal resin crack arose, and the leakage current by an open circuit according remarkable moisture-proof degradation to the corrosion of a lifting and an electrode or moisture was produced, consequently the semiconductor device had the fault that prolonged dependability could not be guaranteed.
[0004]
[Problem(s) to be Solved by the Invention] This invention was made in order to cancel the above-mentioned fault, there is little effect of moisture absorption, it is especially excellent in the moisture resistance after solder bath immersion, and solder thermal resistance, and has neither peeling by closure resin, the semiconductor chip or closure resin, and the leadframe, nor generating of an internal resin crack, and there is also neither an open circuit by the corrosion of an electrode nor generating of the leakage current by moisture, and it is going to offer the epoxy resin constituent and the semi-conductor sealing arrangement which can guarantee dependability over a long period of time.

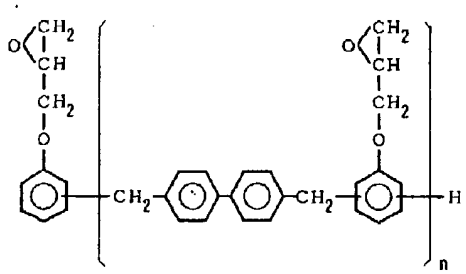
[0005]
[Means for Solving the Problem] As a result of repeating research wholeheartedly in order to attain the above-mentioned object, by using specific phenol resin for a specific epoxy resin as a curing agent, this invention person used to find out that the resin constituent excellent in moisture resistance and solder thermal resistance is obtained, and used to complete this invention.
[0006] namely, this invention -- (A) -- the epoxy resin shown by the following general formula, [0007]
[Formula 5]



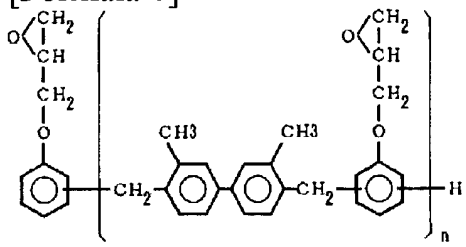
(however, the inside R1 of a formula -- Cj H2j+1 set -- j, k, l, and m list -- n 0 -- or -- -- one or more integers are expressed) [in / R3 carries out Cl H21.+1 set, and, as for R4, R2 carries out the table of the Cm H2m+1 set for Ck H2k+1 set, respectively, and / each radical]
(B) Phenol resin shown by the following general formula [0008]
[Formula 6]



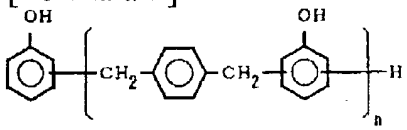
(however, j and k list -- n 0 -- or -- -- one or more integers are expressed) [in / as for the inside R5 of a formula, R6 carries out the table of the Ck H2k+1 set for Cj H2j+1 set, respectively, and / each radical]
(C) It is the epoxy resin constituent which uses a minerals bulking agent and the (D) hardening accelerator as an indispensable component, and is characterized by coming to contain the minerals bulking agent (aforementioned [C]) at 50 - 95% of the weight of a rate to a resin constituent. Moreover, it is the semi-conductor sealing arrangement characterized by coming to close a semiconductor chip with the hardened material of this epoxy resin constituent.
[0009] Hereafter, this invention is explained to a detail.
[0010] As a (A) epoxy resin used for this invention, what is shown by the aforementioned general formula-ization 5 is used, and it can be used, without being restricted to especially the molecular weight etc. as a concrete compound -- for example [0011]
[Formula 7]



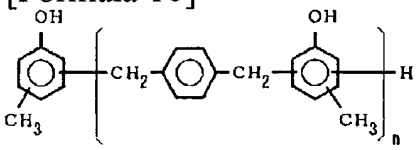
[0012] (However, the inside n of a formula is 0 or 1 The above integer is expressed)
[0013]
[Formula 8]



(However, the inside of a formula and n are 0 or 1 The above integer is expressed) etc. -- it is mentioned and these are independent -- or -- Two or more sorts can use it, mixing. Moreover, to these epoxy resins, a novolak mold epoxy resin, an EPIBISU system epoxy resin, and other common well-known epoxy resins can be used together.
[0014] As (B) phenol resin used for this invention, the phenol resin shown by the aforementioned general formula-ization 6 can be used. as a concrete compound -- for example [0015]
[Formula 9]



(However, the inside of a formula and n are 0 or 1 The above integer is expressed)
[0016]
[Formula 10]



(-- however, the inside of a formula and n -- 0 or 1 -- the above integer is expressed --) -- it is mentioned. Moreover, the novolak mold phenol resin which phenols, such as a phenol and alkylphenol, and the formaldehyde or the paraformaldehyde other than this phenol resin is made to react, and is obtained, and these modified resin can be used together.
[0017] Although what is generally used is widely used as a (C) minerals bulking agent used for this invention, high impurity concentration is low also in them, and it is the mean particle diameter of 30 micrometers. The following silica powder can use it preferably.

Mean particle diameter is 30 micrometers. If it exceeds, moisture resistance and a moldability are not inferior and desirable. As for the blending ratio of coal of a minerals bulking agent, it is desirable to contain at 50 - 95% of the weight of a rate to the whole resin constituent. If the rate has the large hygroscopicity of a resin constituent, and is inferior to the moisture resistance after solder immersion and exceeds 95 % of the weight at less than 50 % of the weight, a fluidity is not extremely inferior to a moldability, and desirable.

[0018] As a (D) hardening accelerator used for this invention, the Lynn system hardening accelerator, an imidazole system hardening accelerator, a DBU system hardening accelerator, other hardening accelerators, etc. are used widely. these are independent -- or -- Two or more sorts can be used together. The blending ratio of coal of a hardening accelerator is 0.01-5 to a resin constituent. It is desirable to blend so that weight % content of may be done. The rate has the long gel time of a resin constituent at less than 0.01 % of the weight, and a hardening property also worsens, and it is 5. A fluidity is not [that worsen, and it is inferior to a moldability and an electrical property is also further inferior to moisture resistance, and] extremely desirable if weight % is exceeded.

[0019] Although the epoxy resin constituent of this invention uses as an indispensable component the specific epoxy resin and the specific phenol resin which were mentioned above, a minerals bulking agent, and a hardening accelerator The need is accepted in the limit which is not contrary to the object of this invention. For example, natural waxes Release agents, such as synthetic waxes, a metal salt of straight-chain fatty acid, acid amides, ester, and paraffin, Addition combination of coloring agents, such as flame retarders, such as an antimony trioxide, carbon black, and red ocher, a silane coupling agent, the low stress grant agent of a rubber system or a silicone system, etc. can be carried out suitably.

[0020] As a general approach in the case of preparing the epoxy resin constituent of this invention as a molding material The raw material component which chose as the predetermined presentation ratio the component of the specific epoxy resin mentioned above, specific phenol resin, a minerals bulking agent and a hardening accelerator, and others is blended. After mixing to homogeneity enough by a mixer etc., mixed processing by the melting mixing processing by the hot calender roll or the kneader is performed further, and subsequently cooling solidification is carried out, and it can grind in suitable magnitude and can consider as a molding material. In this way, the obtained molding material can make the outstanding property and dependability give, if it applies to closure of electronic parts including a semiconductor device, or an electrical part, a coat, an insulation, etc.

[0021] The semi-conductor sealing arrangement of this invention can be easily manufactured by closing a semiconductor chip using the molding material mentioned above. Especially as a semiconductor chip which closes, it is not limited for an integrated circuit, a large-scale integrated circuit, a transistor, a thyristor, diode, etc., for example. As the most general approach of closure, although there is a low voltage transfer-molding method, closure by injection molding, compression molding, casting, etc. is also possible. A molding material is heated and stiffened in the case of closure, and the semi-conductor

sealing arrangement eventually closed with this hardened material is obtained. As for hardening by heating, it is desirable to heat more than 150 ** and to make it harden.
[0022]
[Function] By having used the specific epoxy resin and phenol resin which were mentioned above, the glass transition temperature of a resin constituent rises, a heat mechanical property and low stress nature of the sealing arrangement [the epoxy resin constituent and semi-conductor sealing arrangement] of this invention improve, generating of the resin crack after solder immersion and a solder reflow of them is lost, and its damp-proof degradation decreases.
[0023]
[Example] Next, this invention is not limited by these examples although an example explains this invention. In the following examples and examples of a comparison, "% of the weight" is meant"%."
[0024] Epoxy resin shown in the example 1-ization 7 Phenol resin shown in ** 9 8.9% 6.1%, 84% of silica powder, hardening accelerator 0.3%, ester wax 0.3% and silane coupling agent 0.4% was mixed in ordinary temperature, it kneaded at further 90-95 degrees C, cooling grinding of this was carried out, and the molding material (A) was manufactured.
[0025] Epoxy resin 5.9 % of ** 7 used in the example 2 example 1, and phenol resin of ** 9 used in the example 1 4.1%, 89.0% of silica powder, hardening accelerator 0.3%, ester wax 0.3% and silane coupling agent 0.4% was mixed in ordinary temperature, it kneaded at further 90-95 degrees C, cooling grinding of this was carried out, and the molding material (B) was manufactured.
[0026] Example of comparison 1o-cresol novolak mold epoxy resin 9.8 %, 5.2% of novolak mold phenol resin, 84% of silica powder, hardening accelerator 0.3%, ester wax 0.3% and silane coupling agent 0.4% was mixed and the molding material (C) was manufactured like the example 1.
[0027] Phenol resin of ** 9 used in example of comparison 2 biphenyl mold epoxy resin (weight per epoxy equivalent 193) 5.2 %, and the example 1 4.8%, 89% of silica powder, hardening accelerator 0.3%, ester wax 0.3% and silane coupling agent 0.4% was mixed, it kneaded at further 90-95 degrees C, cooling grinding of this was carried out, and the molding material (D) was manufactured.
[0028] In this way, carry out transfer impregnation, it was made to harden in the metal mold heated to 175 ** using manufactured molding material A- (D), the semiconductor chip was closed, and the semi-conductor sealing arrangement was manufactured. Although the result was shown in a table 1 about these semi-conductor sealing arrangements since many trials were performed, the epoxy resin constituent and semi-conductor sealing arrangement of this invention are excellent in moisture resistance and solder thermal resistance, and were able to check the remarkable effectiveness of this invention.
[0029]
[A table 1]

(単位)

例 / 特性	実施例 1	実施例 2	比較例 1	比較例 2
成形材料	A	B	C	D
吸水率（%）*1	0.39	0.32	0.47	0.34
ガラス転移温度（℃）*2	125	125	160	125
曲げ強さ（kgf／mm²）*3				
常温	18.0	18.0	16.0	18.0
220 ℃	2.7	2.8	2.3	2.8
PCT*4 [半田浴浸漬後]				
(不良数／サンプル数)				
20 h	0／30	0／30	0／30	0／30
40 h	0／30	0／30	0／30	0／30
100 h	0／30	0／30	0／30	0／30
200 h	0／30	0／30	8／30	0／30
300 h	0／30	0／30	21／30	0／30
400 h	0／30	0／30	30／30	0／30
500 h	0／30	0／30	−	0／30
1000 h	0／30	0／30	−	0／30
耐クラック性*5				
(不良数／試料数)	1／20	0／20	20／20	0／20
(剥離枚数／試料数)	8／20	1／20	−	5／20

*1 : the mold goods of the diameter of 50mm and thickness 3 mm were made by transfer molding, and this was measured with the weight which left it for 24 hours and increased into the saturated steam of 127 degrees C and 2.5 atmospheric pressures.
*2 : it is at structure and 175 degree C about the same mold goods as the case of water absorption. Postcure of 8 hours was performed, and it considered as the test piece of suitable magnitude, and measured using the apparatus for thermomechanical analysis.
*3 It examined according to :JIS-K-6911.
*4 : -- a molding material is used -- the chip made from silicon which has aluminum wiring of two -- the usual 42 alloy frame -- pasting up -- 175 ** 175 after transfer-molding for 2 minutes ** Postcure of 8 hours was performed. In this way, beforehand, the obtained mold goods were immersed in the solder bath of 250 ** for 10 seconds, after [40 degrees C 95%RH, and 100 hours] carrying out moisture absorption processing. Then, 127 ** and 2.5 The humidity resistance test was performed in the saturated steam of an atmospheric pressure, and the time amount from which 50% open circuit (defect generating) by aluminum corrosion takes place was evaluated.
*5 : A 8x8 mm dummy chip is dedicated to a QFP (14x14x1.4 mm) package, a molding material is used, and it is at 175 **. With 175 ** after transfer-molding for 2 minutes Postcure of 8 hours was performed. In this way, after carrying out moisture absorption processing of 85 degrees C, 85%, and 96 hours, it let the manufactured semi-conductor sealing arrangement pass at the reflow furnace of Max 240 **. Then, the package front face was observed with the stereoscopic microscope, and the existence of generating of an external resin crack was evaluated. Moreover, in the ultrasonic-crack-inspect measurement machine, the exfoliation phenomenon on the rear face of a die pad was observed, and the

existence of exfoliation more than 5 % was evaluated.

[0030]

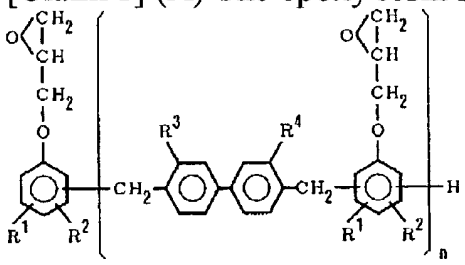
[Effect of the Invention] The epoxy resin constituent and semi-conductor sealing arrangement of this invention can be excellent in moisture resistance and solder thermal resistance, there can be little effect by moisture absorption, the open circuit by the corrosion of an electrode, generating of the leakage current by moisture, etc. can be reduced remarkably, and, moreover, dependability can be guaranteed over a long time so that clearly from the above explanation and a table 1.

[Translation done.]

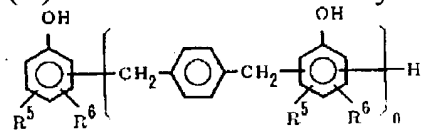
* NOTICES *

CLAIMS

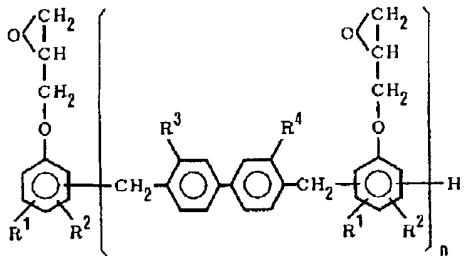
[Claim(s)]
[Claim 1] (A) The epoxy resin shown by the following general formula, [Formula 1]



(however, the inside R1 of a formula -- Cj H2j+1 set -- j, k, l, and m list -- n 0 -- or -- -- one or more integers are expressed) [in / R3 carries out Cl H2l.+1 set, and, as for R4, R2 carries out the table of the Cm H2m+1 set for Ck H2k+1 set, respectively, and / each radical]
(B) Phenol resin shown by the following general formula [** 2]

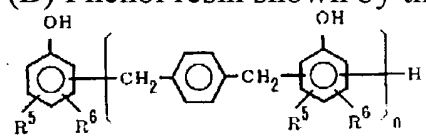


(however, j and k list -- n 0 -- or -- -- one or more integers are expressed) [in / as for the inside R5 of a formula, R6 carries out the table of the Ck H2k+1 set for Cj H2j+1 set, respectively, and / each radical]
(C) Epoxy resin constituent which uses a minerals bulking agent and the (D) hardening accelerator as an indispensable component, and is characterized by coming to contain the minerals bulking agent (aforementioned [C]) at 50 - 95% of the weight of a rate to a resin constituent.
[Claim 2] (A) The epoxy resin shown by the following general formula, [Formula 3]



(however, the inside R1 of a formula -- Cj H2j+1 set -- j, k, l, and m list -- n 0 -- or -- -- one or more integers are expressed) [in / R3 carries out Cl H2l.+1 set, and, as for R4, R2 carries out the table of the Cm H2m+1 set for Ck H2k+1 set, respectively, and / each radical]

(B) Phenol resin shown by the following general formula [** 4]



(however, j and k list -- n 0 -- or -- -- one or more integers are expressed) [in / as for the inside R5 of a formula, R6 carries out the table of the Ck H2k+1 set for Cj H2j+1 set, respectively, and / each radical]

(C) Semi-conductor sealing arrangement which uses a minerals bulking agent and the (D) hardening accelerator as an indispensable component, and is characterized by coming to close a semiconductor chip with the hardened material of the epoxy resin constituent which contained the minerals bulking agent (aforementioned [C]) at 50 - 95% of the weight of a rate to the resin constituent.

[Translation done.]

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	59/62	ＮＪＲ			59/62	ＮＪＲ	
Ｃ０８Ｌ	63/00	ＮＫＴ		Ｃ０８Ｌ	63/00	ＮＫＴ	
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	23/31						

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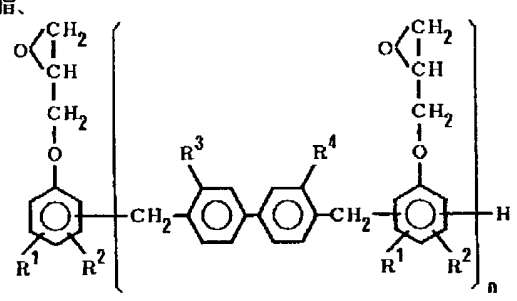
(54)【発明の名称】　エポキシ樹脂組成物および半導体封止装置

(57)【要約】

【構成】　本発明は、（Ａ）次式で表されるエポキシ樹脂、



（Ｂ）フェノールアラルキル樹脂、（Ｃ）無機質充填剤および（Ｄ）硬化促進剤を必須成分とし、樹脂組成物に対して前記（Ｃ）無機質充填剤を50～95重量％含有してなるエポキシ樹脂組成物であり、またこのエポキシ樹脂組成物の硬化物で、半導体チップが封止されてなる半導体封止装置である。

【効果】　本発明のエポキシ樹脂組成物及び半導体封止装置は、耐湿性、半田耐熱性に優れ、吸湿による影響が少なく、電極の腐食による断線や水分によるリーク電流の発生等を著しく低減することができる。

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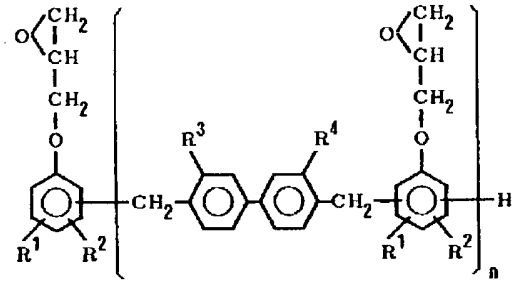
【特許請求の範囲】

【請求項１】　（Ａ）次の一般式で示されるエポキシ樹脂、

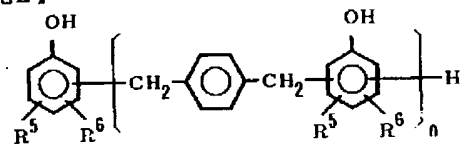
【化１】



（但し、式中R^1 はC_j H_{2j+1}基を、R^2 はC_k H_{2k+1}基を、R^3 はC_l H_{2l+1}基を、R^4 はC_m H_{2m+1}基をそれぞれ表し、各基におけるj 、k 、l 及びm 並びにn は0又は 1以上の整数を表す）

（Ｂ）次の一般式で示されるフェノール樹脂

【化２】



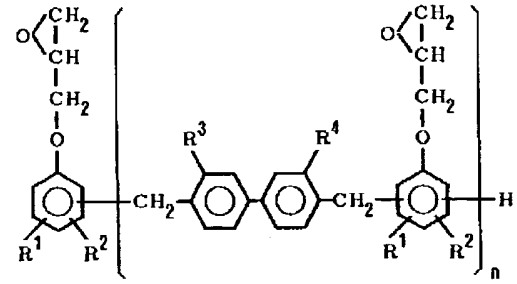
（但し、式中R^5 はC_j H_{2j+1}基を、R^6 はC_k H_{2k+1}基をそれぞれ表し、各基におけるj 及びk 並びにn は0又は 1以上の整数を表す）

（Ｃ）無機質充填剤および

（Ｄ）硬化促進剤を必須成分とし、樹脂組成物に対して前記（Ｃ）無機質充填剤を50～95重量％の割合で含有してなることを特徴とするエポキシ樹脂組成物。

【請求項２】　（Ａ）次の一般式で示されるエポキシ樹脂、

【化３】



（但し、式中R^1 はC_j H_{2j+1}基を、R^2 はC_k H_{2k+1}基を、R^3 はC_l H_{2l+1}基を、R^4 はC_m H_{2m+1}基をそれぞれ表し、各基におけるj 、k 、l 及びm 並びにn は0又は 1以上の整数を表す）

（Ｂ）次の一般式で示されるフェノール樹脂

【化４】

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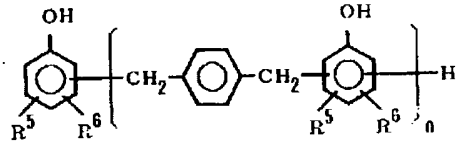


（但し、式中R^5 はC_j H_{2j+1}基を、R^6 はC_k H_{2k+1}基をそれぞれ表し、各基におけるj 及びk 並びにn は0又は 1以上の整数を表す）

（Ｃ）無機質充填剤および

（Ｄ）硬化促進剤を必須成分とし、樹脂組成物に対して前記（Ｃ）無機質充填剤を50～95重量％の割合で含有したエポキシ樹脂組成物の硬化物で、半導体チップが封止されてなることを特徴とする半導体封止装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、耐湿性、半田耐熱性に優れたエポキシ樹脂組成物およびその組成物によって半導体チップを封止した半導体封止装置に関する。

【０００２】

【従来の技術】近年、半導体集積回路の分野において、高集積化、高信頼性化の技術開発と同時に半導体装置の実装工程の自動化が推進されている。例えば、フラットパッケージ型の半導体装置を回路基板に取り付ける場合に、従来、リードピン毎に半田付けを行っていたが、最近では半田浸漬方式や半田リフロー方式が採用されている。

【０００３】従来のノボラック型エポキシ樹脂等のエポキシ樹脂、ノボラック型フェノール樹脂及びシリカ粉末からなる樹脂組成物によって封止した半導体装置は、装置全体の半田浴浸漬を行うと耐湿性が低下するという欠点があった。特に吸湿した半導体装置を浸漬すると、封止樹脂と半導体チップ、あるいは封止樹脂とリードフレームとの間の剥がれや、内部樹脂クラックが生じて著しい耐湿劣化を起こし、電極の腐食による断線や水分によるリーク電流を生じ、その結果、半導体装置は、長期間の信頼性を保証することができないという欠点があった。

【０００４】

【発明が解決しようとする課題】本発明は、上記の欠点を解消するためになされたもので、吸湿の影響が少なく、特に半田浴浸漬後の耐湿性、半田耐熱性に優れ、封止樹脂と半導体チップあるいは封止樹脂とリードフレームとの剥がれや内部樹脂クラックの発生がなく、また電極の腐食による断線や水分によるリーク電流の発生もなく、長期信頼性を保証できるエポキシ樹脂組成物および半導体封止装置を提供しようとするものである。

【０００５】

【課題を解決するための手段】本発明者は、上記の目的を達成しようと鋭意研究を重ねた結果、特定のエポキシ樹脂に硬化剤として特定のフェノール樹脂を用いること

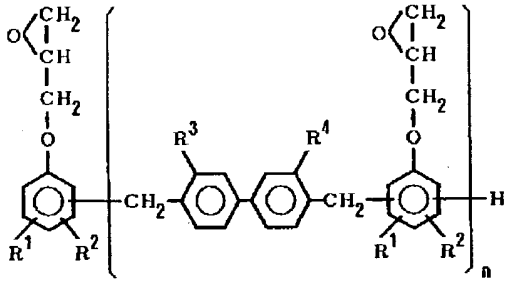
によって、耐湿性、半田耐熱性に優れた樹脂組成物が得られることを見いだし、本発明を完成したものである。

【0006】即ち、本発明は、

（A）次の一般式で示されるエポキシ樹脂、

【0007】

【化5】

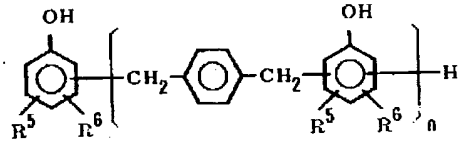


（但し、式中R^1 はC_j H_{2j+1}基を、R^2 はC_k H_{2k+1}基を、R^3 はC_l H_{2l+1}基を、R^4 はC_m H_{2m+1}基をそれぞれ表し、各基におけるj 、k 、l 及びm 並びにn は0又は 1以上の整数を表す）

（B）次の一般式で示されるフェノール樹脂

【0008】

【化6】



（但し、式中R^5 はC_j H_{2j+1}基を、R^6 はC_k H_{2k+1}基をそれぞれ表し、各基におけるj 及びk 並びにn は 0又は 1以上の整数を表す）

（C）無機質充填剤および

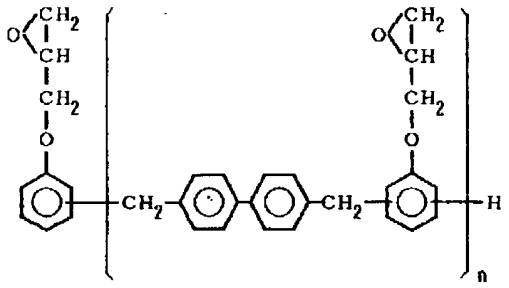
（D）硬化促進剤を必須成分とし、樹脂組成物に対して前記（C）無機質充填剤を50～95重量%の割合で含有してなることを特徴とするエポキシ樹脂組成物である。またこのエポキシ樹脂組成物の硬化物で、半導体チップが封止されてなることを特徴とする半導体封止装置である。

【0009】以下、本発明を詳細に説明する。

【0010】本発明に用いる（A）エポキシ樹脂としては、前記の一般式化5で示されるものが使用され、その分子量等に特に制限されることなく使用することができる。具体的な化合物として、例えば

【0011】

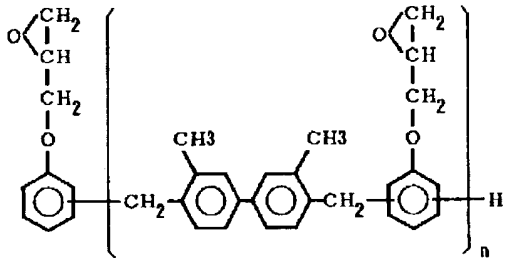
【化7】



【0012】（但し、式中n は0 又は1 以上の整数を表す）

【0013】

【化8】

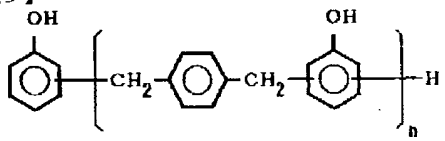


（但し、式中、n は0 又は1 以上の整数を表す）等が挙げられ、これらは単独または 2種以上混合して使用することができる。また、これらのエポキシ樹脂には、ノボラック型エポキシ樹脂やエピビス系エポキシ樹脂、その他の一般公知のエポキシ樹脂を併用することができる。

【0014】本発明に用いる（B）フェノール樹脂としては、前記の一般式化6で示されるフェノール樹脂を使用することができる。具体的な化合物として、例えば

【0015】

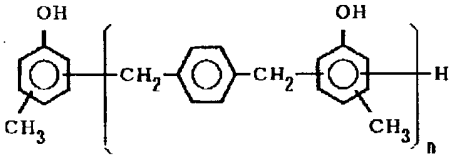
【化9】



（但し、式中、n は0 又は1 以上の整数を表す）

【0016】

【化10】



（但し、式中、n は0 又は1 以上の整数を表す）が挙げられる。また、このフェノール樹脂の他にフェノール、アルキルフェノール等のフェノール類と、ホルムアルデヒド或いはパラホルムアルデヒドとを反応させて得られるノボラック型フェノール樹脂およびこれらの変性樹脂

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を併用することができる。

【００１７】本発明に用いる（Ｃ）無機質充填剤としては、一般に使用されているものが広く使用されるが、それらの中でも不純物濃度が低く、平均粒径30μm 以下のシリカ粉末が好ましく使用することができる。平均粒径が30μm を超えると耐湿性および成形性が劣り好ましくない。無機質充填剤の配合割合は、全体の樹脂組成物に対して50～95重量％の割合で含有することが望ましい。その割合が50重量％未満では、樹脂組成物の吸湿性が大きく、半田浸漬後の耐湿性に劣り、また、95重量％を超えると極端に流動性が悪くなり、成形性に劣り好ましくない。

【００１８】本発明に用いる（Ｄ）硬化促進剤としては、リン系硬化促進剤、イミダゾール系硬化促進剤、ＤＢＵ系硬化促進剤、その他の硬化促進剤等が広く使用される。これらは単独又は 2種以上併用することができる。硬化促進剤の配合割合は、樹脂組成物に対して0.01～5 重量％含有するように配合することが望ましい。その割合が0.01重量％未満では樹脂組成物のゲルタイムが長く、硬化特性も悪くなり、また、5 重量％を超えると極端に流動性が悪くなって成形性に劣り、さらに電気特性も悪くなり耐湿性に劣り好ましくない。

【００１９】本発明のエポキシ樹脂組成物は、前述した特定のエポキシ樹脂、特定のフェノール樹脂、無機質充填剤および硬化促進剤を必須成分とするが、本発明の目的に反しない限度において、また必要に応じて、例えば天然ワックス類、合成ワックス類、直鎖脂肪酸の金属塩、酸アミド類、エステル類、パラフィン類等の離型剤、三酸化アンチモン等の難燃剤、カーボンブラック、ベンガラ等の着色剤、シランカップリング剤、ゴム系やシリコーン系の低応力付与剤等を適宜、添加配合することができる。

【００２０】本発明のエポキシ樹脂組成物を成形材料として調製する場合の一般的な方法としては、前述した特定のエポキシ樹脂、特定のフェノール樹脂、無機質充填剤および硬化促進剤その他の成分を所定の組成比に選択した原料成分を配合し、ミキサー等によって十分均一に混合した後、さらに熱ロールによる溶融混合処理又はニーダ等による混合処理を行い、次いで冷却固化させ、適当な大きさに粉砕して成形材料とすることができる。こうして得られた成形材料は、半導体装置をはじめとする電子部品あるいは電気部品の封止、被覆、絶縁等に適用すれば、優れた特性と信頼性を付与させることができる。

【００２１】本発明の半導体封止装置は、上述した成形材料を用いて、半導体チップを封止することにより容易に製造することができる。封止を行う半導体チップとしては、例えば、集積回路、大規模集積回路、トランジスタ、サイリスタ、ダイオード等で特に限定されるものではない。封止の最も一般的な方法としては、低圧トランスファー成形法があるが、射出成形、圧縮成形、注型等による封止も可能である。成形材料は封止の際に加熱して硬化させ、最終的にはこの硬化物によって封止された半導体封止装置が得られる。加熱による硬化は、150 ℃以上に加熱して硬化させることが望ましい。

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【００２２】

【作用】本発明のエポキシ樹脂組成物および半導体封止装置は、前述した特定のエポキシ樹脂、フェノール樹脂を用いたことによって、樹脂組成物のガラス転移温度が上昇し、熱機械的特性と低応力性が向上し、半田浸漬、半田リフロー後の樹脂クラックの発生がなくなり、耐湿性劣化が少なくなるものである。

【００２３】

【実施例】次に本発明を実施例によって説明するが、本発明はこれらの実施例によって限定されるものではない。以下の実施例及び比較例において「％」とは「重量％」を意味する。

【００２４】実施例１

化７に示したエポキシ樹脂 8.9％、化９に示したフェノール樹脂 6.1％、シリカ粉末84％、硬化促進剤 0.3％、エステルワックス 0.3％およびシランカップリング剤 0.4％を常温で混合し、さらに90～95℃で混練してこれを冷却粉砕して成形材料（Ａ）を製造した。

【００２５】実施例２

実施例１で用いた化７のエポキシ樹脂5.9 ％と実施例１で用いた化９のフェノール樹脂 4.1％、シリカ粉末89.0％、硬化促進剤 0.3％、エステルワックス 0.3％およびシランカップリング剤 0.4％を常温で混合し、さらに90～95℃で混練してこれを冷却粉砕して成形材料（Ｂ）を製造した。

【００２６】比較例１

o-クレゾールノボラック型エポキシ樹脂9.8 ％、ノボラック型フェノール樹脂5.2％、シリカ粉末84％、硬化促進剤 0.3％、エステルワックス 0.3％およびシランカップリング剤 0.4％を混合し、実施例１と同様にして成形材料（Ｃ）を製造した。

【００２７】比較例２

ビフェニル型エポキシ樹脂（エポキシ当量193 ）5.2％、実施例１で用いた化９のフェノール樹脂 4.8％、シリカ粉末89％、硬化促進剤 0.3％、エステルワックス 0.3％およびシランカップリング剤 0.4％を混合し、さらに90～95℃で混練してこれを冷却粉砕して成形材料（Ｄ）を製造した。

【００２８】こうして製造した成形材料Ａ）～（Ｄ）を用いて、175 ℃に加熱した金型内にトランスファー注入し、硬化させて半導体チップを封止して半導体封止装置を製造した。これらの半導体封止装置について、諸試験を行ったのでその結果を表１に示したが、本発明のエポキシ樹脂組成物及び半導体封止装置は、耐湿性、半田耐熱性に優れており、本発明の顕著な効果を確認すること

ができた。

【0029】

＊【表1】

(単位)

例 / 特性	実施例 1	実施例 2	比較例 1	比較例 2
成形材料	A	B	C	D
吸水率（%）＊1	0.39	0.32	0.47	0.34
ガラス転移温度（℃）＊2	125	125	160	125
曲げ強さ（kgf／mm²）＊3				
常温	18.0	18.0	16.0	18.0
220 ℃	2.7	2.8	2.3	2.8
PCT＊4 [半田浴浸漬後]				
(不良数／サンプル数)				
20 h	0／30	0／30	0／30	0／30
40 h	0／30	0／30	0／30	0／30
100 h	0／30	0／30	0／30	0／30
200 h	0／30	0／30	8／30	0／30
300 h	0／30	0／30	21／30	0／30
400 h	0／30	0／30	30／30	0／30
500 h	0／30	0／30	－	0／30
1000 h	0／30	0／30	－	0／30
耐クラック性＊5				
(不良数／試料数)	1／20	0／20	20／20	0／20
(剥離枚数／試料数)	8／20	1／20	－	5／20

＊1 ：トランスファー成形によって直径50mm、厚さ3 mmの成形品を作り、これを127℃，2.5気圧の飽和水蒸気中に24時間放置し、増加した重量によって測定した。

＊2 ：吸水率の場合と同様な成形品を作り、175℃で8時間の後硬化を行い、適当な大きさの試験片とし、熱機械分析装置を用いて測定した。

＊3 ：ＪＩＳ－Ｋ－６９１１に準じて試験した。

＊4 ：成形材料を用いて、2本のアルミニウム配線を有するシリコン製チップを、通常の42アロイフレームに接着し、175 ℃で 2分間トランスファー成形した後、175 ℃で 8時間の後硬化を行った。こうして得た成形品を予め、40℃，95%ＲＨ，100時間の吸湿処理した後、250 ℃の半田浴に10秒間浸漬した。その後、127 ℃，2.5 気圧の飽和水蒸気中で耐湿試験を行い、アルミニウム腐食による50%断線（不良発生）の起こる時間を評価した。

＊5 ： 8×8 mmダミーチップをＱＦＰ（14×14×1.4 m ※m）パッケージに納め、成形材料を用いて、175 ℃で 2分間トランスファー成形した後、175 ℃で 8時間の後硬化を行った。こうして製造した半導体封止装置を85℃，85%，96時間の吸湿処理をした後、Max 240 ℃のリフロー炉に通した。その後、実体顕微鏡でパッケージ表面を観察し、外部樹脂クラックの発生の有無を評価した。また、超音波探傷測定機において、ダイパッド裏面の剥離現象を観察し、5 %以上の剥離の有無を評価した。

【0030】

【発明の効果】以上の説明及び表1から明らかなように、本発明のエポキシ樹脂組成物及び半導体封止装置は、耐湿性、半田耐熱性に優れ、吸湿による影響が少なく、電極の腐食による断線や水分によるリーク電流の発生等を著しく低減することができ、しかも長時間にわたって信頼性を保証することができる。